Faculty of Science

Department of Physics

Syllabus

2022 Pattern

For

T.Y.B.Sc. (Sem-V)

in Physics

For Academic Year 2024-2025

Anekant Education Society's

TULJARAM CHATURCHAND COLLEGE OF ARTS, SCIENCE AND COMMERCE, BARAMATI

(Autonomous Status)

(Affiliated to Savitribai Phule Pune University, Pune)

Anekant Education Society's

Tuljaram Chaturchand College

of Arts, Science and Commerce, Baramati

(Autonomous Status)

(Affiliated to Savitribai Phule Pune University, Pune)

T.Y.B. Sc. Sem-V (2022 Pattern) **[Physics]**

For academic Year 2024-2025

Semester	Paper Code	Title of Paper	No of Credits
V	USPH 351	Mathematical Methods of Physics-II	3
	USPH 352	Solid State Physics	3
	USPH 353	Classical Mechanics	3
	USPH 354	Atomic and Molecular Physics	3
	USPH 355	Elements of Material Science	3
	USPH 356 (A)	Renewable Energy Sources	3
	USPH 356 (B)	Physics and Technology of Sensors	
	USPH 356 (C)	Biophysics	
	USPH 357	Practical I	2
	USPH 358	Practical II	2
	USPH 359	Practical III	2
Total			**24**
	USPH 361	Classical Electrodynamics	3
	USPH 362	Quantum Mechanics	3
	USPH 363	Thermodynamics and Statistical Physics	3
	USPH 364	Nuclear Physics	3

VI	USPH 365A	Electronics II	3
	USPH 365B	Advanced Electronics	
	USPH 366 (A)	Solar Energy Conversion Devices	3
	USPH 366 (B)	Sensors and its Applications	
	USPH 366 (C)	Physics of Nanomaterials	
	USPH 367	Practical IV	2
	USPH 368	Practical V	2
	USPH 369	Project	2
Total			**24**

CBCS Syllabus for T.Y.B.Sc. Physics (2022 Pattern)

Name of the Programme : B.Sc. Physics
Programme Code : USPH
Class : T.Y.B.Sc.
Semester : V
Course Type : Theory
Course Code : USPH 351
Course Title : Mathematical methods in Physics-II
No. of Credits : 03
No. of Teaching Hours : 45

Course Objectives:

1. To learn mathematical tools required to solve physical problem.
2. To understand mathematical concepts related to physics.
3. To understand generalized coordinate system

Course Outcomes

After successful completion of the course student will be able to

CO1. Learn some mathematical techniques required to understand the physical phenomena at the undergraduate level.

CO2.The students will solve non-homogeneous differential equations and partial differential equations using simple methods.

CO3. The students are expected to be able to solve simple problems on Matrix.

CO4.Understand the generalized coordinate system and transformation equation between Cartesian coordinate and generalized coordinates.

CO5.Can understand, model and analyze the fundamental physical processes of nature.

CO6. Can suggest mathematical models to problems they face and solve them by various (approximate/analytical/numerical) approaches.

CO7. Can analyze systems that contain probabilistic parts; can do error analysis.

Topics and Learning Points

1. Curvilinear Co-ordinates **(12 L)**

1.1 Introduction to Cartesian

1.2 Spherical polar and Cylindrical co-ordinate systems

1.3 Transformation equations, General Curvilinear co-ordinate system

1.4 Co-ordinate surface, lines, length, and volume elements in curvilinear system

1.5 Orthogonal Curvilinear co-ordinate system,

1.6 Expressions for: a) gradient b) divergence c) Laplacian d) Curl in Cartesian system

2. Special Theory of Relativity **(11 L)**

2.1 Introduction of Special Theory of Relativity and its limitations.

2.2 Newtonian relativity Galilean transformation equation

2.3 Lorentz transformations

2.4 Length contraction, Transformation of velocities

2.5 Variation of mass with velocity, Mass-energy relation

2.6 Problems

3. Differential Equations **(10 L)**

3.1 Partial differential equations

3.2 Degree, order, linearity, and homogeneity (Revision)

3.3 Method of separation of variables, Singular points

3.4 Frobenius method for power series

3.5 Solution of Legendre, Hermite and Bessel differential equation

3.6 Problems

4. Special Functions **(8L)**

4.1 Generating function for Legendre, Hermite Polynomials

4.2 Recurrence relations, differential equations, and properties of special functions

4.3 Bessel function of first kind and their properties

4.4 Problems

5. Matrix **(4L)**

5.1 Definition and Types of Matrix

5.2 Matrix representation

5.3 Caley -Hamilton theorem of matrix

5.4 Problems

References Book:

1. Mathematical method for Physicists, Arfken and Weber, Academic press New York.
2. Mathematical Physics, Rajput, Pragati Prakashan
3. Mathematical methods in the Physical sciences – Marry L. Boas, John Willy and Sons Publication.

Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B.Sc (Sem- V) **Subject**: Physics

Course: Mathematical methods in Physics-II **Course Code**: USPH 351

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	2	1	2	2	2	1	2	2
CO 2	3	3	1	2	2	2	1	1	2
CO 3	3	3	1	2	2	2	1	1	2
CO 4	3	2	1	3	2	2	1	2	2
CO 5	3	3	2	3	3	3	2	2	3
CO 6	3	3	2	3	3	3	2	2	3
CO7	3	3	2	3	3	3	2	2	3

Justification

PO1: Disciplinary Knowledge

- CO1 to CO7 are strongly related (3) as they require a thorough understanding of mathematical techniques and physical modeling necessary for undergraduate physics courses.

PO2: Critical Thinking and Problem Solving

- CO2, CO3, CO5, CO6, and CO7 have strong relations (3) because they require solving differential equations, analyzing physical systems, and performing probabilistic error analysis.
- CO1 and CO4 have a moderate (2) relation as they support foundational concepts.

PO3: Social Competence

- CO5 to CO7 are partially related (2) as they contribute to problem-solving within collaborative environments and real-world applications.

PO4: Research-related Skills and Scientific Temper

- CO4, CO5, CO6, and CO7 have a strong (3) relationship as they promote research abilities through modeling, system analysis, and probabilistic reasoning.
- CO1 to CO3 have moderate (2) relations as they provide mathematical tools for future research.

PO5: Trans-disciplinary Knowledge

- CO5, CO6, and CO7 have a strong (3) relation as they integrate mathematical and physical knowledge to solve complex trans-disciplinary problems.

PO6: Personal and Professional Competence

- CO5, CO6, and CO7 are highly related (3) as they develop analytical and problem-solving skills applicable in professional contexts.

PO7: Effective Citizenship and Ethics

- CO5, CO6, and CO7 have partial relations (2) as they can foster ethical scientific practices in problem-solving and analysis.

PO8: Environment and Sustainability

- CO4 to CO7 have a moderate (2) relationship as mathematical modeling and system analysis are applicable to environmental sustainability studies.

PO9: Self-directed and Life-long Learning

- CO1 to CO7 are highly related (3) as they promote continuous learning of mathematical methods and physical analysis tools essential for lifelong learning in scientific fields.

CBCS Syllabus for T.Y.B.Sc. Physics (2022 Pattern)

Name of the Programme	**:** B.Sc. Physics
Programme Code	**:** USPH
Class	**:** T.Y.B.Sc.
Semester	**:** V
Course Type	**:** Theory
Course Code	**:** USPH 352
Course Title	**:** Solid State Physics
No. of Credits	**:** 03
No. of Teaching Hours	**:** 45

Course Objectives:

1 Understand the basics of crystallography.

2 Understand electrical properties of metals and Band theory of solids.

3 Understand the basics of magnetism.

4 To study the basics of Solid-State Physics and Semiconductor Physics

Course Outcomes:

This syllabus will also help students to lay a foundation for Materials science, electronics, and more advanced subjects like condensed matter in future.

CO1: List seven crystal systems.

CO2: Explain free electron theory and band theory.

CO3: Calculate lattice parameter from given XRD pattern.

CO4: Identify the structure of materials.

CO5: Evaluate the density of state equation in 3D.

CO6: Specify the importance of magnetic materials and classification based on susceptibility value.

CO7: classification of hard and soft magnet based on Hysteresis curve of magnetic sample.

Topics and Learning Points

Unit1. Free Electron Theory of Solids **(14L)**

1.1 Classical free electron theory of metals

1.2 Drawbacks of classical theory

1.3 Energy levels and Density of orbital in 1D and 3D

1.4 Bloch theorem (only statement and properties)

1.5 Nearly free electron model, Fermi energy, Fermi level

1.6 Origin of energy gap

1.7 Distinction between metal, Semiconductor and insulator

1.8 Hall Effect

1.9 Problems

Unit2. Crystalline Solids **(15 L)**

2.1 Introduction: Classification of solids (crystalline, amorphous & polycrystalline)

2.2 Lattice, Basis, Translational vectors

2.3 Primitive unit cell, Symmetry operations

2.4 Different types of lattices 2D and 3D (Bravais lattices)

2.5 Miller indices inter planer distances.

2.6 Number of atoms per unit cell

2.7 Co-ordination number

2.8 Atomic radius and packing fraction for SC, BCC and FCC structures

2.9 Study of NaCl, diamond, CsCl, ZnS and HCP crystals

2.10 Concept of reciprocal lattice and its properties with proof.

2.11 X-ray diffraction: Crystal as a grating,

2.12 Bragg's law and Bragg's Diffraction condition in direct and reciprocal lattice

2.13 Experimental methods of X-ray diffraction: Laue method, Rotating Crystal method, Powder (Debye Scherer) method

2.14 Problems

Unit3. Semiconductor **(6 L)**

3.1 Intrinsic semiconductor

3.2 Conductivity

3.3 Carrier concentrations

3.4 Donor and Acceptor impurities

3.5 Extrinsic Semiconductor

3.6 Charge densities in a Semiconductor

3.7 Diffusion,

3.8 Carrier lifetime, the p-n junction as a diode

3.9 Volt-Ampere characteristics

3.10 Problems

Unit4. Magnetism **(10 L)**

4.1 Diamagnetism

4.2 Langevin theory of Diamagnetism

4.3 Application of diamagnetic material

4.4 Superconductor, Occurrence of Superconductivity

4.5 Critical magnetic field and Meissner effect

4.6 Paramagnetism, Langevin theory of Para magnetism

4.7 ferromagnetism, ferromagnetic domains

4.8 Hysteresis, Curie temperature

4.9 Anti-ferromagnetism, Neel temperature

4.10 Problems

Reference Books:

1. Solid State Physics-S.O.Pillai, 3rd Edition, New Age International (P) Ltd, Publisher, (1999).
2. Solid State Physics – Kakani and Hemrajani, S. Chand Publication.
3. Solid State Physics BySaxena, Gupta and Saxena, PragatiPrakation.
4. Introduction to Solid State Physics- Charles Kittel, John Wiley and Sons, 7th Edition.
5. Solid State Physics-A.J.Dekker, Macmillan India Ltd, (1998).
6. Solid State Physics- R.K. Puri, V.K. Babbar, S. Chand Publication.
7. Problems in Solid State Physics-S.O. Pillai, New Age International (P) Ltd.
8. Solid State Physics-Palanyswamy.
9. Solid State Physics- David, Snoke, Pearson Publication.
10. Semiconductor Physics and Devices: Donald Neamen (3rd Ed.) TMH.
11. S. M. Sze, 2nd ed, Semiconductor Devices: Physics and Technology. John Wiley & Sons.

Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B.Sc (Sem-V) **Subject**: Physics

Course: Solid State Physics **Course Code**: USPH 352

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	2	1	1	2	2	1	1	2
CO 2	3	3	1	2	2	2	1	2	3
CO 3	3	3	1	3	3	2	1	2	3
CO 4	3	3	2	3	2	2	2	2	3
CO 5	3	3	1	3	3	3	1	2	3
CO 6	3	2	1	2	2	3	2	2	3
CO7	3	3	1	2	2	3	2	2	3

Justification

PO1: Disciplinary Knowledge

- All COs strongly relate (3) as they cover essential knowledge in crystallography, material science, magnetism, and solid-state physics.

PO2: Critical Thinking and Problem-Solving

- CO2, CO3, CO4, CO5, and CO7 have a strong (3) relationship due to their problem-solving nature, including band theory, XRD analysis, and magnetic behavior analysis.

PO3: Social Competence

- CO4 and CO6 have partial relevance (2) because material identification and understanding magnetic properties can have industrial and societal applications.

PO4: Research-related Skills and Scientific Temper

- CO3, CO4, and CO5 are strongly related (3) as they promote experimental analysis, mathematical modeling, and theoretical evaluation, essential for research.

PO5: Trans-disciplinary Knowledge

- CO3, CO5, and CO7 have strong relations (3) as they bridge physics, material science, and applications in engineering fields.

PO6: Personal and Professional Competence

- CO5, CO6, and CO7 are highly related (3) as they develop analysis and classification skills important for professional practice in materials science.

PO7: Effective Citizenship and Ethics

- CO4, CO6, and CO7 have partial relations (2) as they touch upon ethical considerations in industrial and technological applications of magnetic materials.

PO8: Environment and Sustainability

- CO3 to CO7 moderately relate (2) as they can have applications in developing energy-efficient materials and sustainable technologies.

PO9: Self-directed and Life-long Learning

- All COs have a strong relation (3) as they promote continuous learning of materials science concepts and problem-solving techniques essential for scientific growth.

CBCS Syllabus for T.Y.B.Sc. Physics (2022 Pattern)

Name of the Programme : B.Sc. Physics
Programme Code : USPH
Class : T.Y.B.Sc.
Semester : V
Course Type : Theory
Course Code : USPH 353
Course Title : Classical Mechanics
No. of Credits : 03
No. of Teaching Hours : 45

Course Objectives:

1. To understand the Newton's laws and applications of Newton's laws of motion
2. To understand the Central forces, Types of central forces and Kepler's laws of planetary Motion.
3. To know the Lagrangian approach in classical mechanics.
4. To understand theory of scattering in detail

Course Outcomes

After completion of the course, the student should be able to:

CO1: The students will introduce about methods of solving equations of motions i.e. the Newton's laws of motion, linear momentum, angular momentum, and knowledge about the applications of Newton's laws of motion.

CO2: The students should be able to understand central forces and types of central forces in detail, ideas regarding equations of orbit and deduction of Kepler's laws.

CO3: This paper enables the students to understand the Lagrangian approach in classical mechanics.

CO4: The students should be able to understand theory of scattering, types of scattering and differential cross section.

CO5: Explain necessity of considering constraints.

CO6: Apply different techniques to find solutions of problems in Mechanics.

CO7: Determine the constraint equations and decide the generalized co- ordinates to be used.

Topics and Learning Points

Unit 1. Mechanics of System of Particles (11 L)

1.1 Introduction

1.2 Newton's laws of motion, Limitations of Newton's Laws, Applications of Newton's laws of motion

1.3 Projectile motion in various medium, Motion of a charged particle in constant electric, magnetic and electromagnetic field

1.4 System of particles

1.5 Centre of mass

1.6 Conservation of linear momentum, angular momentum, energy of system of particles (statements only)

1.7 Problems

Unit 2. Motion in Central Force Field (11 L)

2.1 Types of forces: Forces of Gravitation, Lorentz force, Hooks Force, Frictional Force,

2.2 Fundamental Forces of Nature, Central force

2.3 Equivalent one body problem

2.4 General features of motion

2.5 Equation of orbit, Kepler's laws of planetary motion (statements only)

2.6 Problems

Unit 3. Scattering Theory of Particles (11 L)

3.1 Introduction,

3.2 Elastic and Inelastic Scattering

3.3 Laboratory and Centre of mass system

3.4 Relation between scattering angles in Lab and CM system,

3.5 Inelastic scattering.

3.6 Problems

Unit 4. Lagrangian Formulation (12 L)

4.1 Limitations of Newtonian mechanics,

4.2 Types of constraints, degrees of freedom, generalized coordinates, configuration space

4.3 D'Alembert's principle, Virtual displacement, Principal of virtual work

4.4 Lagrange's equation of motion from D'Alembert's principle,

4.5 Equation of motion of simple pendulum, spring mass arrangement

4.6 Attwood’s machine, particle under gravity by using Lagrangian formulation.

4.7 Problems.

References:

1. Classical mechanics by J.C. Upadhyaya, Himalaya Publishing House.
2. Classical mechanics by N.C. Rana and P.S. Joag, Tata Mc-Graw Hill Publishing Company limited, New Delhi.
3. Classical Mechanics by P.V. Panat, Narosa publishing Home, New Delhi.
4. Classical Mechanics by Kumar, Gupta, Sharma.
5. Classical Mechanics by H. Goldstein, Narosa Publishing Home, New Delhi.
6. Classical Mechanics by D. S. Mathur.
7. Introduction to Classical Mechanics by R. G. Takawale and P. S. Puranik, Tata Mc-Graw Hill Publishing Company Limited, New Delhi.

Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B.Sc (Sem-V) **Subject**: Physics

Course: Classical Mechanics **Course Code**: USPH 353

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	3	1	2	2	2	1	1	2
CO 2	3	3	1	3	2	2	1	2	3
CO 3	3	3	1	3	3	3	1	2	3
CO 4	3	3	1	3	2	3	1	2	3
CO 5	3	2	1	2	3	2	1	2	3
CO 6	3	3	1	3	3	3	1	2	3
CO7	3	3	1	3	3	3	1	2	3

Justification

PO1: Disciplinary Knowledge

- All COs are strongly related (3) as they involve essential knowledge in classical mechanics, including Newtonian and Lagrangian mechanics, scattering, and constraints.

PO2: Critical Thinking and Problem Solving

- CO1, CO2, CO3, CO4, CO6, and CO7 strongly relate (3) as they require problem-solving skills to derive equations of motion, solve mechanics problems, and analyze systems under constraints.

PO3: Social Competence

- All COs have a weak relation (1) since social interaction is minimally involved in learning classical mechanics concepts.

PO4: Research-related Skills and Scientific Temper

- CO2, CO3, CO4, CO6, and CO7 strongly relate (3) as they involve research-oriented skills such as deriving orbit equations, analyzing scattering phenomena, and applying advanced techniques in mechanics.

PO5: Trans-disciplinary Knowledge

- CO3, CO5, CO6, and CO7 have strong relations (3) as they bridge concepts from physics, engineering, and mathematics for solving complex mechanics problems.

PO6: Personal and Professional Competence

- CO3, CO4, CO6, and CO7 strongly relate (3) as they build analytical, problem-solving, and modeling skills essential for professional competence in physics.

PO7: Effective Citizenship and Ethics

- All COs have a weak relation (1) as ethical considerations are not central to classical mechanics learning.

PO8: Environment and Sustainability

- CO2, CO3, CO4, and CO6 have a moderate (2) relation as mechanics principles can be applied to environmental studies and sustainable technologies.

PO9: Self-directed and Life-long Learning

- All COs strongly relate (3) as they promote independent learning of analytical techniques, mechanical problem-solving, and theoretical derivations essential for lifelong learning in science.

CBCS Syllabus for T.Y.B.Sc. Physics (2022 Pattern)

Name of the Programme : B.Sc. Physics
Programme Code : USPH
Class : T.Y.B.Sc.
Semester : V
Course Type : Theory
Course Code : USPH 354
Course Title : Atomic and Molecular Physics
No. of Credits : 03
No. of Teaching Hours : 45

Course Objectives:

After successful completion of the course students will be able to

1. The subject of Atomic and Molecular Physics has reached a significant advancement in high–precision experimental measurement techniques.
2. This area covers a wide spectrum ranging from conventional to new emerging multidisciplinary areas like molecular physics, optical science, especially spectroscopy.
3. In the present syllabus sequence of articles in each chapter enables the student to understand the gradual development of the subject.

Course Outcomes:

Upon successful completion of this course, the student will understand.

CO1: The application of quantum mechanics in atomic physics

CO2: The importance of electron spins, symmetric and antisymmetric wave functions, and vector atom model

CO3: Effect of magnetic field on atoms and its application

CO4: Learn Molecular physics and its applications.

CO5: This course will be useful to get an insight into spectroscopy.

CO6: Relate atomic theory to analyse spectra.

CO7: Evaluate spectroscopic data to identify elements using atomic spectra.

Topics and Learning Points

1. Atomic structure (9L)

1.1 Atomic Models (Rutherford, Bohr, Sommer field)

1.2 Energy levels and spectra

1.3 Vector atom model (Concepts of space and quantization and electron spin)

1.4 Atomic excitation and atomic spectra

1.5 Problems Ref 1 ch4

2. One Valence Electron System (9 L)

2.1 Pauli Exclusion principle and electron configuration, quantum states, Spectral notations of quantum states.

2.2 Energy levels of Na atom, selection rules, spectra of sodium atom.

3. Two valence electron systems (9 L)

3.1 Spectral terms of two electron atoms, LS and JJ coupling schemes.

3.2 Lande's Interval rule, spectra of Helium atom

3.3 Problems, Ref 1: ch7, Ref. 2: ch8 and ch12

4. Zeeman Effect (9 L)

4.1 Early discoveries and developments

4.2 Experimental arrangement

4.3 Normal and anomalous Zeeman Effect

4.4 Stark effect (Qualitative discussion)

4.5 Problems Ref 2 ch10

5. X ray spectroscopy (9 L)

5.1 Nature of X rays

5.2 Discrete and continuous Xray spectra, Daune and Hunt's Rule

5.3 Xray emission spectra

5.4 Mosley's law and its applications

5.5 Auger effect

5.6 Problems Ref 2 ch16

Reference Books:

1. Concepts of Modern Physics 4th edition Arthur Baiser (McGraw Hill International ed)
2. Introduction to Atomic spectra White. H. E (McGraw Hill International edition)
3. Fundamentals of Molecular spectroscopy, C.N. Banwell and E.M Mc Cash (McGraw Hill International edition)
4. Modern Physics, J.B. Rajam

Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B.Sc (Sem- V) **Subject**: Physics

Course: Atomic and Molecular Physics **Course Code**: USPH 354

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	3	1	3	2	2	1	2	3
CO 2	3	3	1	2	2	2	1	2	3
CO 3	3	3	1	2	2	2	1	2	3
CO 4	3	3	1	3	3	3	2	2	3
CO 5	3	3	1	3	3	3	2	2	3
CO 6	3	3	1	3	3	3	2	2	3
CO7	3	3	1	3	3	3	2	2	3

Justification

PO1: Disciplinary Knowledge

- All COs strongly relate (3) as they involve the application of quantum mechanics, atomic physics, molecular physics, and spectroscopy.

PO2: Critical Thinking and Problem Solving

- CO1, CO2, CO3, CO4, CO5, CO6, and CO7 are strongly related (3) as they require analyzing atomic models, wave functions, and interpreting spectroscopic data.

PO3: Social Competence

- All COs have a weak (1) relationship as social interaction is minimally involved in the learning and application of atomic and molecular physics concepts.

PO4: Research-related Skills and Scientific Temper

- CO1, CO4, CO5, CO6, and CO7 are strongly related (3) as they develop research abilities, such as analyzing atomic spectra and understanding the molecular structure.

PO5: Trans-disciplinary Knowledge

- CO4, CO5, CO6, and CO7 have a strong relation (3) since spectroscopy and atomic theory have applications in chemistry, biology, and material science.

PO6: Personal and Professional Competence

- CO4, CO5, CO6, and CO7 have a strong relation (3) as they develop critical data analysis and problem-solving skills crucial for professional competence in physics and spectroscopy-related fields.

PO7: Effective Citizenship and Ethics

- CO4 to CO7 have a partial relation (2) as spectroscopic analysis and molecular physics have industrial and environmental applications, promoting ethical technological practices.

PO8: Environment and Sustainability

- CO1, CO4, CO5, and CO6 moderately relate (2) as spectroscopic techniques and atomic physics can contribute to environmental monitoring and sustainable technologies.

PO9: Self-directed and Life-long Learning

- All COs strongly relate (3) as they promote lifelong learning of quantum mechanics, spectroscopy, and problem-solving techniques.

CBCS Syllabus for T.Y.B.Sc. Physics (2022 Pattern)

Name of the Programme : B.Sc. Physics
Programme Code : USPH
Class : T.Y.B.Sc.
Semester : V
Course Type : Theory
Course Code : USPH 355
Course Title : Elements of Material Science
No. of Credits : 03
No. of Teaching Hours : 45

Course Objectives:

1. Students will demonstrate an understanding of core graduate-level theoretical knowledge in materials science.
2. An ability to use modern techniques, skills, and engineering tools appropriate to materials science.
3. An integrated understanding of structure, properties, processing, and performance of materials systems.

Course Outcomes:

CO1: Describe types of materials, their properties and identify types of defects.

CO2: Explain functional properties of ceramic bulk materials and different nanomaterials.

CO3: Select materials for design and construction. Test materials using different characterization methods with the fundamental principles underlying and connecting the structure and properties

CO4: Students are able to apply knowledge of advanced science and engineering principles to materials systems.

CO5: Students will demonstrate proficiency in the acquisition of data using a variety of laboratory instruments and in the analysis and interpretation of such data.

CO6: An ability to apply knowledge of mathematics, science, and engineering to materials issues.

CO7: Ability to design and conduct experiments and critically analyses and interpret data.

Topics and Learning Points

1. Introduction to Materials Science (12 L)

1.1 Historical perspectives of materials science

1.2 Classification of materials

1.3 Smart materials

1.4 Nano structured Materials

1.5 Organic Materials: Chemistry of polymer molecule, Molecular weight, Molecular structure

1.6 Material Properties: Mechanical, Electrical, Thermal and Magnetic

2. Defects in Solids (12L)

2.1 Types of materials: Conductors, Semiconductors, and Insulators

2.2 Defects in solids: Point, Line, Surface, and Volume

2.3 Solid solutions and their applications, Rules of solid solubility

2.4 Hume-Rothery's Rules of formation of solid solution

2.5 Diffusion in Solids: Introduction, Mechanisms of diffusion, Fick's laws of diffusion, Solution to Fick's second law, Few applications of diffusion process,

2.6 Kirkendall effect with example

3. Phase Diagram (12L)

3.1 Basic terms: System, Surrounding, Component, Coordinates, Phase, Equilibrium.

3.2 Phase Diagram: definition, importance, and objective

3.3 Lever rule, Gibb's phase rule

3.4 Phase diagram of a) Sugar water b) NaCl water

3.5 Types of phase diagrams with construction

3.6 Type-I: Lens type CuNi phase diagram

3.7 Type-II: Only introduction

3.8 Type-III: Eutectic type Pb-Sn phase diagram

3.9 Some applications of phase diagrams

4. Ceramic and Ferrite Materials (9 L)

4.1 Ceramic Phases, Classification of ceramic materials, Ceramic crystals (AX)

4.2 Mechanical behavior of ceramics

4.3 Electric properties of ceramics: dielectrics, semiconductors, piezoelectric

4.4 Magnetic Properties of ceramics: Magnetic Ceramics, hard and soft ferrites.

4.5

Reference books:

1. Elements of materials science and Engineering: H.Van Vlach
2. Materials Science and Engineering: V. Raghavan
3. Material Science: S. L. Kakani and Amit Kakani
4. Solid State Physics:A. J. Dekker
5. Materials Science &Engineering:An Introduction (6th Edition): William D. Callister

Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B.Sc (Sem-V) **Subject**: Physics

Course: Elements of Material Science **Course Code**: USPH 355

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	2	1	2	2	2	1	2	3
CO 2	3	2	1	2	2	2	1	2	3
CO 3	3	3	1	3	3	3	2	2	3
CO 4	3	3	1	3	3	3	2	2	3
CO 5	3	3	1	3	3	3	2	2	3
CO 6	3	3	1	3	3	3	1	2	3
CO7	3	3	1	3	3	3	2	2	3

Justification

PO1: Disciplinary Knowledge

- All COs are strongly related (3) as they cover critical aspects of material science, characterization methods, and material property analysis.

PO2: Critical Thinking and Problem-Solving

- CO3, CO4, CO5, CO6, and CO7 have strong relations (3) since they involve material selection, experimental design, and problem-solving related to materials engineering.

PO3: Social Competence

- All COs have a weak relation (1) as social competence is not a primary focus of material science.

PO4: Research-related Skills and Scientific Temper

- CO3, CO4, CO5, CO6, and CO7 have strong relations (3) due to their emphasis on experimental analysis, testing, and interpretation of data in materials research.

PO5: Trans-disciplinary Knowledge

- CO3, CO4, CO5, CO6, and CO7 have strong relations (3) since materials science connects physics, chemistry, and engineering disciplines.

PO6: Personal and Professional Competence

- CO3 to CO7 are strongly related (3) as they develop proficiency in experimental design, data analysis, and material system analysis for professional competence.

PO7: Effective Citizenship and Ethics

- CO3, CO4, CO5, and CO7 moderately relate (2) due to the potential applications of materials in sustainable industrial practices and ethical concerns in material selection.

PO8: Environment and Sustainability

- CO1 to CO7 have moderate relations (2) as material science applications contribute to sustainable technologies and environmental monitoring.

PO9: Self-directed and Life-long Learning

- All COs strongly relate (3) as they encourage continuous learning and exploration of new materials and their applications.

CBCS Syllabus for T.Y.B.Sc. Physics (2022 Pattern)

Name of the Programme	: B.Sc. Physics
Programme Code	: USPH
Class	: T.Y.B.Sc.
Semester	: V
Course Type	: Theory
Course Code	: USPH 356 (A)
Course Title	: Renewable Energy Sources
No. of Credits	: 03
No. of Teaching Hours	: 45

Course Objectives:

1. To create awareness of environment quality
2. To develop skills in handling equipment's related to solar energy, biogas etc
3. To create manpower in renewable energy
4. Understand the various forms of conventional energy resources.
5. Learn the present energy scenario and the need for energy conservation.
6. Explain the concept of various forms of renewable energy.

Course Outcomes:

CO1: Understand the need of renewable energy resources and latest developments for environmental balance.

CO2: Use of solar energy in the energy production with different applications like - heating, cooling, desalination, power generation, drying, cooking etc for pollution free energy consumption

CO3: Understand concept and use of Wind Energy and the various components used in energy generation.

CO4: Understand the concept of Biomass energy resources and their classification along with marketing of waste for agriculture

CO5: Address various issues of environmental imbalance using promotion of Renewable energy sources than conventional energy resources.

CO6: Illustrate the use of solar energy and the various components used in the energy production with respect to applications like - heating, cooling, desalination, power generation, drying, cooking etc for domestic and rural regions.

CO7: Awareness campaign for the promotion of Solar Energy, Wind energy, Biomass energy resources and biogas Plants- applications for environment sustenance.

Topics and Learning Points

1. Solar Energy **(10 L)**

1.1 Energy resources and forms of energy, Energy from sun

1.2 Solar constant, solar thermal collectors, solar pond, Solar boiler

1.3 Principle of Photovoltaic cell

1.4 Characteristics of solar cell

1.5 Large solar PV system,

1.6 Solar PV power system for space station

1.7 Assembly and maintenance

1.8 Solar charging, solar air heating and cooling system, Thermal pad

1.9 Solar water heaters, solar cookers, solar drying

1.10 Solar photovoltaic system

1.11 Solar energy pumps.

2. Energy Storage System **(10 L)**

2.1 Introduction

2.2 Battery Energy Storage Systems

2.3 Lead Acid Battery Cells,

2.4 Nickel-Cadmium Battery

2.5 Li-ion Battery,

2.6 Advanced Batteries.

2.7 Fuel Cell: Introduction,

2.8 Advantages of Fuel cell power sources,

2.9 Principle and operation of Fuel Cell

2.10 Classification and Types of Fuel Cells

3. Biomass energy **(10 L)**

3.1 Introduction

3.2 Biomass for urban waste and rural waste to biogas energy

3.3 Agricultural waste and agricultural energy crops, fruit farms

3.4 Anaerobic fermentation process in biogas plants

3.5 Principal of marine bioenergy resources

3.6 Bio-hydrogen production

3.7 Isolation of methane from Biogas & packing and its utilization.

3.8 Introduction to gasifiers.

4. Wind Energy **(10 L)**

4.1 Introduction, Basic concept, and component of wind energy conversion

4.2 Types of wind machines

4.3 Application of wind machine

4.4 Hybrid wind energy systems wind + diesel power

4.5 Wind + conventional grid

4.6 Wind + Photovoltaic system etc.

4.7 Wind to electrical energy conversion alternatives

4.8 Wind map of India,

4.9 Wind electrical energy stations in India.

5. Energy Audit **(05 L)**

5.1 Introduction

5.2 Types of energy audits

5.3 Walk through energy audit

5.4 Case Study, Audit report

5.5 Intermediate & Compressive Energy audit

5.6 Procedure of energy auditing.

5.7 Case Study: 1. Solar PV Panel

5.8 Biogas production from kitchen waste

References:

1. Biomass Renegerable Energy – D.O.hall and R.P. Overeed (John Wiley and Sons, NewYork, 1987)
2. Biomass for energy in the developing countries – D.O.Hall, G.W.barnard and P.A.Moss(Pergamon Press Ltd. 1982)
3. Thermo chemical processing of Biomass, Bridgurater A V.
4. Biomass as Fuel – L.P.White (Academic press1981)
5. Biomass Gasification Principles and Technology, Energy technology review No. 67, T.B. Read (Noyes Data Corp., 1981)

List of experiments:

1. Study of solar cell characteristics
2. PV- IV characteristics of solar cell
3. Performance evaluation of box type Solar Cooker
4. Recording the amount of sunlight receives throughout a day using Sunshine recorder.
5. Utilizing the latent heat absorbed by the condensing water steam using Solar Still.
6. Measure the solar radiation flux density using Pyrometer.

Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B.Sc (Sem- V) **Subject**: Physics

Course: Renewable Energy Sources **Course Code**: USPH 356 (A)

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	3	2	3	2	2	3	3	3
CO 2	3	3	2	3	3	3	3	3	3
CO 3	3	3	2	3	3	3	3	3	3
CO 4	3	3	2	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3
CO 6	3	3	2	3	3	3	3	3	3
CO7	3	3	3	3	3	3	3	3	3

Justification

PO1: Disciplinary Knowledge

- All COs strongly relate (3) as they involve comprehensive knowledge of renewable energy sources and their practical applications.

PO2: Critical Thinking and Problem-Solving

- All COs have a strong relation (3) since they require analytical thinking to identify, implement, and optimize renewable energy solutions for sustainable development.

PO3: Social Competence

- CO1, CO5, and CO7 have strong relations (3) as they promote community awareness and collaboration for renewable energy solutions.

PO4: Research-related Skills and Scientific Temper

- CO1 to CO7 strongly relate (3) as they encourage exploration, innovation, and application of scientific methods to renewable energy and environmental sustainability.

PO5: Trans-disciplinary Knowledge

- All COs have strong relations (3) since renewable energy combines principles of physics, engineering, environmental science, and economics.

PO6: Personal and Professional Competence

- CO2 to CO7 have strong relations (3) as they build skills for designing and managing renewable energy systems and developing market strategies for energy solutions.

PO7: Effective Citizenship and Ethics

- All COs strongly relate (3) as they promote responsible citizenship through sustainable energy practices and ethical decision-making in energy resource management.

PO8: Environment and Sustainability

- All COs strongly relate (3) due to their focus on environmental protection and the promotion of renewable energy solutions.

PO9: Self-directed and Life-long Learning

- All COs strongly relate (3) as they encourage continuous learning and adaptation to advancements in renewable energy technologies.

CBCS Syllabus for T.Y.B.Sc. Physics (2022 Pattern)

Name of the Programme	**:** B.Sc. Physics
Programme Code	**:** USPH
Class	**:** T.Y.B.Sc.
Semester	**:** V
Course Type	**:** Theory
Course Code	**:** USPH 356 (B)
Course Title	**:** Physics and Technology of sensors
No. of Credits	**:** 03
No. of Teaching Hours	**:** 45

Course Outcomes:

On successful completion of this course students will be able to do the following:

CO1: Understand the concept of sensors and its characteristics.

CO2: Understand the practical approach in design of technology based on different sensors.

CO3: Learn various sensor materials and technology used in designing sensors.

CO4: Getting information about various sensing parameter conditions for instrumentation.

CO5: Design experiments or demo using sensors for application.

CO6: Use of knowledge in electronics-based project work for demonstration.

CO7: Application of logic and electronics for new ideas and societal demands.

Topics and Learning Points

Unit 1. Sensors Classification and Characteristics [5 L]

1.1 Fundamentals and Characteristics Sensors

1.2 Signals and Systems

1.3 Sensor Classification, General specifications of sensors and transducers, Sensor Characteristics, Selection Criteria for sensors and transducers

1.4 Problems

Unit 2: Physical Principles of Sensing [12 L]

2.1 Resistive Sensors, Pressure Inductive sensor, Magnetic flow meter, Piezo electric sensors

2.2 Photo electric and Photo voltaic

2.3 Temperature and Thermal Properties of Material, Heat Transfer

2.4 Problems

Unit 3. Acceleration and Pressure Sensors [12 L]

3.1 Accelerometer characteristics, Capacitive accelerometers, Piezo-resistive accelerometers, Piezoelectric accelerometers

3.2 Thermal accelerometers heated plate accelerometer, heated gas accelerometer

3.3 Gyroscopes, rotor gyroscope, optical gyroscopes, piezoelectric cables, Strain Gauges, piezoelectric force sensors

3.4 Pressure gauges: mercury pressure sensor, bellows, membranes and thin plates, optoelectronic sensors.

3.5 Problems

Unit 4. Flow, Acoustic and Humidity Sensors [12 L]

4.1 Basics of flow dynamics, Pressure gradient technique, Thermal transport sensors, Ultrasonic sensors, Electromagnetic Sensors

4.2 Acoustic sensors: resistive microphones, condenser microphones, Fiber optic microphone

4.3 Piezoelectric microphones, electric microphones, Solid state acoustic detectors, Humidity and moisture sensors

4.4 Concept of humidity, Capacitive sensors, Electrical conductivity sensors – thermal conductivity sensor.

4.5 Problems

References:

1. D. Patranabis, Sensors and Transducers, 2nd ed., Prentice-Hall of India (2005).
2. Jacob Fraden, Handbook of Modern Sensors: Physics, Design, and Application, 3rd edition, Springer (2004).
3. J. Fraden, Handbook of Modern Sensors: Physical, Designs, and Applications, AIP Press, Springer

4. D. Patranabis, Sensors and Transducers, PHI Publication, New Delhi3. Mechatronics- Ganesh S. Hegde, Published by University Science Press (An imprint of Laxmi Publication Private Limited).
5. Sensors and Transducers- Dr. A. D. Shaligram

List of Experiments:

1. Characteristics of Piezo-electric Transducer
2. Characteristics of Thermocouple
3. Operation of digital humidity sensor
4. Study of resistive soil moisture sensor
5. Study of digital response an IR motion sensor

Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B.Sc (Sem- V) **Subject**: Physics

Course: Physics and Technology of Sensors **Course Code**: USPH 356 (B)

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	2	1	2	1	1	1	1	2
CO 2	3	3	2	2	2	2	1	1	3
CO 3	3	2	1	2	2	1	1	2	2
CO 4	3	3	1	2	2	2	1	2	2
CO 5	2	3	2	3	2	3	2	2	3
CO 6	2	3	2	3	3	3	2	2	3
CO7	2	3	3	2	3	3	3	3	3

Justification

PO1: Disciplinary Knowledge

- CO1, CO2, CO3, CO4 have a strong (3) relation as they involve understanding fundamental sensor concepts, materials, and their characteristics.
- CO5, CO6, CO7 have a moderate (2) relation as they involve applied knowledge in designing and implementing sensor-based solutions.

PO2: Critical Thinking and Problem Solving

- CO2, CO4, CO5, CO6, CO7 have a strong (3) relation as they require analytical thinking for solving sensor-related problems.
- CO1, CO3 have a moderate (2) relation since understanding sensor concepts also requires some level of problem-solving ability.

PO3: Social Competence

- CO7 has a strong (3) relation since it involves designing solutions for societal demands.
- CO2, CO5, CO6 have a moderate (2) relation as they involve teamwork and collaboration in projects and demonstrations.
- CO1, CO3, CO4 have a weak (1) relation since they focus more on technical knowledge rather than social aspects.

PO4: Research-Related Skills and Scientific Temper

- CO5, CO6 have a strong (3) relation as they involve experimental design and innovation using sensors.
- CO1, CO2, CO3, CO4, CO7 have a moderate (2) relation as they encourage scientific inquiry and technical research.

PO5: Trans-Disciplinary Knowledge

- CO6, CO7 have a strong (3) relation as they involve integrating knowledge from electronics, physics, and engineering for real-world applications.
- CO2, CO3, CO4, CO5 have a moderate (2) relation since sensor technology overlaps with various disciplines.
- CO1 has a weak (1) relation since it mainly focuses on the fundamental concepts of sensors.

PO6: Personal and Professional Competence

- CO5, CO6, CO7 have a strong (3) relation as they require hands-on experience and professionalism in project work.
- CO2, CO4 have a moderate (2) relation as they develop practical competence in sensor-based applications.
- CO1, CO3 have a weak (1) relation since they focus more on conceptual knowledge.

PO7: Effective Citizenship and Ethics

- CO7 has a strong (3) relation as it focuses on designing applications that fulfill societal needs.
- CO5, CO6 have a moderate (2) relation since real-world applications often involve ethical considerations.
- CO1, CO2, CO3, CO4 have a weak (1) relation as they mainly focus on technical aspects.

PO8: Environment and Sustainability

- CO7 has a strong (3) relation as it encourages developing energy-efficient and eco-friendly sensor solutions.
- CO3, CO4, CO5, CO6 have a moderate (2) relation since sensor applications can be designed for environmental monitoring.
- CO1, CO2 have a weak (1) relation as they primarily focus on the technical aspects of sensors rather than sustainability.

PO9: Self-Directed and Life-Long Learning

- CO2, CO5, CO6, CO7 have a strong (3) relation since they involve innovation and continuous learning in sensor technology.
- CO1, CO3, CO4 have a moderate (2) relation as they contribute to foundational knowledge, encouraging further learning.

CBCS Syllabus for T.Y.B.Sc. Physics (2022 Pattern)

Name of the Programme : B.Sc. Physics
Programme Code : USPH
Class : T.Y.B.Sc.
Semester : V
Course Type : Theory
Course Code : USPH 356 (C)
Course Title : Biophysics
No. of Credits : 03
No. of Teaching Hours : 45

Course Outcomes:

On successful completion of this course students will be able to do the following:

CO1: Understand Basic Structure of Cell

CO2: Identify Biophysical Techniques

CO3: Properties and their significance

CO4: Working of Nervous System

CO5: Apply the knowledge of Physics in Living things.

CO6: Understand the principles of electrical signalling in biological systems, including nerve impulses and action potentials.

CO7: Understand the role of biophysics in the study of sensory receptors and signal transduction

Topics and Learning Points

Unit 1: Introduction of Biophysics **[16L]**

1.1 History of Biophysics, Concept of Biophysics and Physical properties applied to biology- Surface tension, Viscosity, adsorption, diffusion, osmosis

1.2 Cell: Animal and plant cell, types of cell, Functional aspects of cell membrane, cytoplasm, nucleus, mitochondria and chloroplast Protein structure (Primary and Secondary), amino acid structure, Genetic code- symmetry, DNA structure

1.3 Photosynthesis process: - electron transport, Gibbs's free energy, Redox couple, Redox potential, Oxidation and reduction, Examples of redox potential in biological system.

Unit 2: Bio-Potentials **[8L]**

2.1 Bioelectric signals: structure of neuron, resting potential, action Potential

2.2 Nernst equation Bio-electrodes- Half-cell potential

2.3 Polarizable and non-polarizable electrodes, Microelectrode- metal and glass electrodes.

Unit 3: Bio-instruments **[7L]**

3.1 Basic principle, Construction and working of colorimeter

3.2 Spectrophotometer, PH meter and Centrifuge measurement

3.3 Electron Microscope: SEM, TEM.

Unit 4: Radiation Biophysics **[14 L]**

4.1 Definition, Units of Radioactivity and radiation doses, Types of radiation (Ionizing and non- ionizing)

4.2 Applications: PET (Positron Emission Tomography)

4.3 NMR (Nuclear Magnetic Resonance)

4.4 MRI (Magnetic Resonance Imaging Techniques)

4.5 Ultrasonography, CT (Computed Tomography) Scan.

References:

1. Introduction to Biophysics - by P. Narayanan.New Age P.
2. Medical Instrumentation - by Khandpur, TMH
3. Laboratory Manuals of Biophysics Instruments - by P.B. Vidyasagar
4. Biophysics -by Vatsala Piramal, Dominant Publisher and Distributors, New Delhi-110002
5. Textbook of Biophysics - by R.N. Roy
6. Photosynthesis - by Hall and Rao.
7. Introduction to Biomedical Equipment Technology (Fourth Edition) by-Joseph J.Carr
8. Text Book of Bio-medical Electronics-by S.S. Agrawal

List of Experiments:

1. Recording and analysis of ECG signals
2. Verification of Beer's and Lambert's Law
3. Absorption spectrum of Blood/Chlorophyll.
4. pH value of Amino acids.

5. Bimolecular model building using standard kits.
6. Separation of components of Milk/Chlorophyll using centrifuge machine.

Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B.Sc (Sem- V) **Subject**: Physics

Course: Biophysics **Course Code**: USPH 356 (C)

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	2	1	2	1	1	1	1	2
CO 2	3	3	2	3	2	2	1	2	3
CO 3	3	2	1	2	2	1	1	2	2
CO 4	3	3	2	2	2	2	1	2	2
CO 5	3	3	2	3	3	3	2	2	3
CO 6	3	3	2	3	3	3	2	2	3
CO7	3	3	2	3	3	3	3	3	3

Justification

PO1: Disciplinary Knowledge

- CO1, CO2, CO3, CO4, CO5, CO6, CO7 have a strong (3) relation as they contribute directly to knowledge in biophysics, cellular structure, and physiological processes.

PO2: Critical Thinking and Problem Solving

- CO2, CO4, CO5, CO6, CO7 have a strong (3) relation as they require logical thinking and problem-solving skills in biological systems and physics applications.
- CO1, CO3 have a moderate (2) relation as they help in understanding fundamental concepts but do not directly involve problem-solving.

PO3: Social Competence

- CO2, CO4, CO5, CO6, CO7 have a moderate (2) relation since they involve teamwork, collaboration, and real-world applications in medicine and healthcare.
- CO1, CO3 have a weak (1) relation as they mainly focus on theoretical aspects.

PO4: Research-Related Skills and Scientific Temper

- CO2, CO5, CO6, CO7 have a strong (3) relation as they develop scientific research capabilities related to biological physics and instrumentation.
- CO1, CO3, CO4 have a moderate (2) relation as they provide conceptual knowledge that can be further explored in research.

PO5: Trans-Disciplinary Knowledge

- CO5, CO6, CO7 have a strong (3) relation as they integrate physics, biology, and medical sciences.
- CO2, CO3, CO4 have a moderate (2) relation since they involve biophysical techniques that apply principles from multiple fields.
- CO1 has a weak (1) relation as it mainly focuses on biological structure rather than interdisciplinary aspects.

PO6: Personal and Professional Competence

- CO5, CO6, CO7 have a strong (3) relation as they develop skills applicable in medical, healthcare, and research professions.
- CO2, CO4 have a moderate (2) relation since they include hands-on experimental techniques and biophysical analysis.
- CO1, CO3 have a weak (1) relation as they provide foundational knowledge but do not directly contribute to professional skills.

PO7: Effective Citizenship and Ethics

- CO7 has a strong (3) relation since it deals with the role of biophysics in human sensory systems and healthcare applications, which have ethical and social implications.
- CO5, CO6 have a moderate (2) relation as they apply physics to biological and medical sciences, impacting human well-being.
- CO1, CO2, CO3, CO4 have a weak (1) relation since they primarily focus on theoretical aspects.

PO8: Environment and Sustainability

- CO7 has a strong (3) relation as it focuses on sensory receptors and signal transduction, which are key in biomedical and environmental studies.
- CO2, CO3, CO4, CO5, CO6 have a moderate (2) relation as they contribute to sustainable healthcare and biophysics applications.
- CO1 has a weak (1) relation since it focuses on cell structure without direct environmental implications.

PO9: Self-Directed and Life-Long Learning

- CO5, CO6, CO7 have a strong (3) relation since they encourage continuous exploration of biophysics, neuroscience, and technological advancements in medical applications.

- CO1, CO2, CO3, CO4 have a moderate (2) relation as they provide a foundation for further learning and research.

CBCS Syllabus for T.Y.B.Sc. Physics (2022 Pattern)

Name of the Programme	: B.Sc. Physics
Programme Code	: USPH
Class	: T.Y.B.Sc.
Semester	: V
Course Type	: Practical
Course Code	: USPH 357
Course Title	: Practical-I
No. of Credits	: 02
No. of Teaching Hours	: 60

Course Outcomes:

At the end of this course, students will be able to:

CO1: Acquire technical and manipulative skills in using laboratory equipment, tools and materials.

CO2: Demonstrate an ability to collect data through observation and/or experimentation and interpreting data.

CO3: Demonstrate an understanding of laboratory procedures including safety and scientific methods.

CO4: Demonstrate a deeper understanding of abstract concepts and theories gained by experiencing and visualizing them as authentic phenomena.

CO5: Acquire the complementary skills of collaborative learning and teamwork in laboratory settings.

CO6: Use of experiment to analyse various experimental parameters concerning their application .

CO7: Experimental Models for easy understanding and explanation Physics concepts.

Student has to perform any EIGHT experiments from the list given below plus any TWO experiments from the optional subject. **(TOTAL 10 experiments)**

1. Moment of Inertia by Bifilar suspension
2. Young's modulus by Koeing method
3. Katter's pendulum

4. Y by vibration of wooden scale
5. Determination of Resolving Power of grating
6. Determination of wavelength of light by Michelson's interferometer
7. Young's modulus by Newton's rings
8. Determination of wavelength by Constant deviation spectrometer
9. Determination of refractive index of liquid using hollow prism.
10. Lloyd's mirror
11. Study of diffraction using a reflection grating (metal ruler)
12. Determination of wavelength of given source by Newton's rings

Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B.Sc (Sem- V) **Subject**: Physics

Course: Practical- I **Course Code**: USPH 357

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	2	1	2	2	3	1	1	2
CO 2	3	3	2	3	2	2	1	2	3
CO 3	3	2	1	2	2	3	2	2	2
CO 4	3	3	1	3	2	2	1	2	3
CO 5	2	2	3	2	2	3	2	2	3
CO 6	3	3	2	3	3	3	2	2	3
CO7	3	3	2	3	3	3	2	2	3

Justification

PO1: Disciplinary Knowledge

- CO1, CO2, CO3, CO4, CO6, CO7 have a strong (3) relation as they involve understanding laboratory skills, experimental techniques, and scientific theories.
- CO5 has a moderate (2) relation since it focuses on teamwork rather than direct disciplinary knowledge.

PO2: Critical Thinking and Problem Solving

- CO2, CO4, CO6, CO7 have a strong (3) relation as they require analyzing experimental data, understanding abstract concepts, and solving problems using experimental methods.
- CO1, CO3, CO5 have a moderate (2) relation as they involve technical procedures and teamwork, which contribute to problem-solving indirectly.

PO3: Social Competence

- CO5, CO6, CO7 have a moderate (2) relation as they encourage teamwork and communication in laboratory environments.
- CO1, CO2, CO3, CO4 have a weak (1) relation since they focus more on individual technical skills rather than social interaction.

PO4: Research-Related Skills and Scientific Temper

- CO2, CO4, CO6, CO7 have a strong (3) relation as they focus on data collection, experimental analysis, and deeper conceptual understanding.
- CO1, CO3, CO5 have a moderate (2) relation as they contribute to scientific inquiry and laboratory-based research skills.

PO5: Trans-Disciplinary Knowledge

- CO6, CO7 have a strong (3) relation as they integrate physics with real-world applications, requiring interdisciplinary knowledge.
- CO1, CO2, CO3, CO4, CO5 have a moderate (2) relation since they contribute to a broader understanding of experimental science.

PO6: Personal and Professional Competence

- CO1, CO5, CO6, CO7 have a strong (3) relation as they involve hands-on laboratory skills, teamwork, and experimental analysis, which are essential professional competencies.
- CO2, CO3, CO4 have a moderate (2) relation as they help develop scientific reasoning and lab safety awareness.

PO7: Effective Citizenship and Ethics

- CO3, CO5, CO6, CO7 have a moderate (2) relation as they promote ethical laboratory practices and collaborative learning.
- CO1, CO2, CO4 have a weak (1) relation since they mainly focus on scientific concepts rather than ethical aspects.

PO8: Environment and Sustainability

- CO2, CO3, CO5, CO6, CO7 have a moderate (2) relation as they encourage sustainable lab practices and applications of physics in environmental studies.
- CO1, CO4 have a weak (1) relation since they primarily focus on laboratory skills and theoretical understanding.

PO9: Self-Directed and Life-Long Learning

- CO2, CO4, CO5, CO6, CO7 have a strong (3) relation since they develop experimental and analytical skills that encourage continuous learning and adaptation.
- CO1, CO3 have a moderate (2) relation as they provide a foundation for lifelong learning in laboratory science.

CBCS Syllabus for T.Y.B.Sc. Physics (2022 Pattern)

Name of the Programme	: B.Sc. Physics
Programme Code	: USPH
Class	: T.Y.B.Sc.
Semester	: V
Course Type	: Practical
Course Code	: USPH 358
Course Title	: Practical-II
No. of Credits	: 02
No. of Teaching Hours	: 60

Course Outcomes:

CO1: Use various instruments and equipment.

CO2: Design experiments to test a hypothesis and/or determine the value of an unknown quantity.

CO3: Investigate the theoretical background to an experiment.

CO4: Set up experimental equipment to implement an experimental approach.

CO5: Analyze data, plot appropriate graphs and reach conclusions from your data analysis.

CO6: Work in a group to plan, implement and report on a project/experiment.

CO7: Experimental Models for easy understanding and explanation Physics concepts.

Total-10 Experiments

Students must perform any **EIGHT** experiments from the list given below plus any **TWO** experiments from the optional subject **(TOTAL 10 experiments).**

1. Characteristics of JFET
2. Design and built astable multivibrator using IC 555/IC 741
3. Integrator and differentiator using IC 741
4. Instrumental amplifier using three op-amps
5. Digital to Analog Converters
6. Schmidt trigger
7. Plotting of graph using MS-Excel
8. Plotting of graph using origin software
9. Study of Multiplexer and Demultiplexer

10. Active Filters (High pass & Low Pass)
11. Temperature controller using AD590
12. Study of IC 7490 as mod 2, mod 5, mod 7 and mod 10 counter

Practical from Optional Course (Any-2)

1. Demonstrations: Any 2 demonstrations equivalent to 2 experiments
2. Study tour with report equivalent to 2 experiments
3. Mini project equivalent to 2 experiments

Computer aided demonstrations (Simulations or animations)

Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B.Sc (Sem- V) **Subject**: Physics

Course: Practical II **Course Code**: USPH 358

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	2	1	2	2	3	1	1	2
CO 2	3	3	2	3	2	3	1	2	3
CO 3	3	2	1	3	2	2	1	2	2
CO 4	3	3	2	3	2	3	1	2	3
CO 5	3	3	2	3	2	3	2	2	3
CO 6	2	2	3	2	2	3	2	2	3
CO7	3	3	2	3	3	3	2	2	3

Justification

PO1: Disciplinary Knowledge

- CO1, CO2, CO3, CO4, CO5, CO7 have a strong (3) relation as they contribute directly to understanding and applying physics concepts, experimental procedures, and analysis.
- CO6 has a moderate (2) relation since it emphasizes teamwork rather than direct disciplinary knowledge.

PO2: Critical Thinking and Problem Solving

- CO2, CO4, CO5, CO7 have a strong (3) relation as they require designing experiments, analyzing data, and interpreting results.
- CO1, CO3, CO6 have a moderate (2) relation since they involve technical knowledge and teamwork, which contribute to problem-solving.

PO3: Social Competence

- CO6, CO7 have a strong (3) relation as they focus on collaborative learning, teamwork, and effective communication in an experimental setting.
- CO2, CO4, CO5 have a moderate (2) relation as they involve group work and discussions for analysis and conclusions.
- CO1, CO3 have a weak (1) relation since they mainly focus on individual technical skills rather than social interaction.

PO4: Research-Related Skills and Scientific Temper

- CO2, CO3, CO4, CO5, CO7 have a strong (3) relation as they contribute to scientific inquiry, hypothesis testing, and structured research methodology.
- CO1, CO6 have a moderate (2) relation as they provide experimental experience but are less focused on research methodology.

PO5: Trans-Disciplinary Knowledge

- CO7 has a strong (3) relation as it integrates physics with practical applications, helping to visualize complex theories.
- CO1, CO2, CO3, CO4, CO5, CO6 have a moderate (2) relation since they contribute to understanding experimental science beyond physics.

PO6: Personal and Professional Competence

- CO1, CO2, CO4, CO5, CO6, CO7 have a strong (3) relation as they contribute to developing hands-on laboratory skills, teamwork, data interpretation, and professional ethics.
- CO3 has a moderate (2) relation since it focuses more on theoretical understanding rather than professional competence.

PO7: Effective Citizenship and Ethics

- CO5, CO6, CO7 have a moderate (2) relation as they promote collaborative work, responsibility, and ethical experimentation practices.
- CO1, CO2, CO3, CO4 have a weak (1) relation since they focus on technical knowledge and experimental design rather than citizenship and ethics.

PO8: Environment and Sustainability

- CO2, CO3, CO5, CO6, CO7 have a moderate (2) relation as they encourage sustainable lab practices and applications of physics in environmental studies.
- CO1, CO4 have a weak (1) relation since they primarily focus on instrument usage and setup rather than sustainability.

PO9: Self-Directed and Life-Long Learning

- CO2, CO4, CO5, CO6, CO7 have a strong (3) relation as they develop experimental and analytical skills that encourage continuous learning and adaptation.

- CO1, CO3 have a moderate (2) relation as they provide a foundation for lifelong learning in experimental physics.

CBCS Syllabus for T.Y.B.Sc. Physics (2022 Pattern)

Name of the Programme	: B.Sc. Physics
Programme Code	: USPH
Class	: T.Y.B.Sc.
Semester	: V
Course Type	: Practical
Course Code	: USPH 359
Course Title	: Practical-III
No. of Credits	: 02
No. of Teaching Hours	: 60

Course Outcomes:

CO1: Acquire technical and manipulative skills in using laboratory equipment, tools and materials.

CO2: Demonstrate an ability to collect data through observation and/or experimentation and interpreting data.

CO3: Demonstrate an understanding of laboratory procedures including safety and scientific methods.

CO4: Demonstrate a deeper understanding of abstract concepts and theories gained by experiencing and visualizing them as authentic phenomena.

CO5: Acquire the complementary skills of collaborative learning and teamwork in laboratory settings.

CO6: Use of experiment to analyse various experimental parameters concerning their application .

CO7: Experimental Models for easy understanding and explanation Physics concepts.

Student has to perform any EIGHT experiments from the list given below plus any TWO experiments from the optional subject. (TOTAL 10 experiments)

1. Charging and discharging of a capacitor
2. Specific heat of graphite
3. Study of Solar constant
4. Transistor characteristics (CE configuration)
5. Thermal conductivity of rubber tube
6. Integrator and differentiator using IC 741

7. Study of Thermocouple
8. Phase shift Oscillator using IC 741
9. Thickness of sharp blade by laser diffraction.
10. Directional characteristics of Microphone
11. AC Wheatstone Bridge
12. Maxwell's Bridge
13. Rigidity Modulus of Brass by electromagnetic vibration
14. 'Y' by flexural vibration of steel bar

Practical From Optional Course (Any-2)

1. Demonstrations: Any 2 demonstrations equivalent to 2 experiments
2. Study tour with report equivalent to 2 experiments
3. Mini project equivalent to 2 experiments

Computer aided demonstrations (Simulations or animations)

Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B.Sc (Sem- V) **Subject**: Physics

Course: Practical-III **Course Code**: USPH 359

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	2	1	2	2	3	1	1	2
CO 2	3	3	2	3	2	3	1	2	3
CO 3	3	2	1	3	2	3	2	2	2
CO 4	3	3	1	3	2	2	1	2	3
CO 5	2	2	3	2	2	3	2	2	3
CO 6	3	3	2	3	3	3	2	2	3
CO7	3	3	2	3	3	3	2	2	3

Justification

PO1: Disciplinary Knowledge

- CO1, CO2, CO3, CO4, CO6, CO7 have a strong (3) relation as they develop technical skills, understanding of experimental procedures, and visualization of concepts.
- CO5 has a moderate (2) relation since it focuses on teamwork rather than direct disciplinary knowledge.

PO2: Critical Thinking and Problem Solving

- CO2, CO4, CO6, CO7 have a strong (3) relation as they require designing experiments, analyzing data, and interpreting results.
- CO1, CO3, CO5 have a moderate (2) relation since they involve technical procedures and teamwork, contributing indirectly to problem-solving.

PO3: Social Competence

- CO5, CO6, CO7 have a moderate (2) relation as they encourage teamwork, collaborative learning, and communication in laboratory environments.
- CO1, CO2, CO3, CO4 have a weak (1) relation since they focus more on individual technical skills rather than social interaction.

PO4: Research-Related Skills and Scientific Temper

- CO2, CO3, CO4, CO6, CO7 have a strong (3) relation as they contribute to scientific inquiry, hypothesis testing, and structured research methodology.
- CO1, CO5 have a moderate (2) relation as they provide experimental experience but are less focused on structured research methods.

PO5: Trans-Disciplinary Knowledge

- CO6, CO7 have a strong (3) relation as they integrate physics with real-world applications, requiring interdisciplinary knowledge.
- CO1, CO2, CO3, CO4, CO5 have a moderate (2) relation since they contribute to a broader understanding of experimental science.

PO6: Personal and Professional Competence

- CO1, CO2, CO3, CO5, CO6, CO7 have a strong (3) relation as they contribute to developing hands-on laboratory skills, teamwork, data interpretation, and professional ethics.
- CO4 has a moderate (2) relation since it focuses more on abstract understanding rather than professional competence.

PO7: Effective Citizenship and Ethics

- CO3, CO5, CO6, CO7 have a moderate (2) relation as they promote ethical laboratory practices and collaborative learning.
- CO1, CO2, CO4 have a weak (1) relation since they mainly focus on scientific concepts rather than ethical aspects.

PO8: Environment and Sustainability

- CO2, CO3, CO5, CO6, CO7 have a moderate (2) relation as they encourage sustainable lab practices and applications of physics in environmental studies.
- CO1, CO4 have a weak (1) relation since they primarily focus on laboratory skills and theoretical understanding.

PO9: Self-Directed and Life-Long Learning

- CO2, CO4, CO5, CO6, CO7 have a strong (3) relation since they develop experimental and analytical skills that encourage continuous learning and adaptation.
- CO1, CO3 have a moderate (2) relation as they provide a foundation for lifelong learning in laboratory science.